

Ethnomathematics-Based Geometry Modules to Enhance Problem-Solving Skills of Islamic Junior High School Students

Ifada Novikasari¹, Lisa Awalia², Noor Elebiary³

^{1&2} Universitas Islam Negeri Prof. K. H. Saifuddin Zuhri Purwokerto, Jawa Tengah, Indonesia.

³ University of Birmingham, United Kingdom.

* Correspondence to: ifa_da@uinsaizu.ac.id

Abstract: This study investigates the effectiveness of ethnomathematics-based learning in enhancing ninth-grade students' mathematical problem-solving skills in geometry at an Islamic junior high school. A quasi-experimental design with pre-test and post-test was employed, involving 47 students divided into an experimental group ($n = 24$) and a control group ($n = 23$). The experimental group received instruction integrating culturally relevant contexts, while the control group received teacher-centered expository instruction. Problem-solving skills were assessed through validated tests targeting comprehension, strategy formulation, execution, and evaluation, and analyzed using normalized gain (N-Gain) and independent-samples t-tests. Results indicated that the experimental group achieved significantly higher N-Gain scores than the control group, with a large effect size, demonstrating that ethnomathematics-based learning effectively fosters higher-order problem-solving abilities. These findings suggest that embedding cultural contexts in mathematics instruction provides a more engaging and enhancing students' problem-solving skills.

Keywords: Ethnomathematics; problem solving; Islamic junior high school.

How To Cite: Novikasari, I., Awalia, L., & Elebiary, N. (2025). Ethnomathematics-Based Geometry Modules to Enhance Problem-Solving Skills of Islamic Junior High School Students. *Al-Ta'lim Journal*, 32(3). doi:<https://doi.org/10.15548/jt.v32i3.952>

Article info: Submitted: 23th April 2024 | Revised: 28th October 2025 | Accepted: 27th November 2025

INTRODUCTION

Education continues to evolve with the changing times. As education is considered a fundamental necessity for human life, it enables individuals to reach higher levels compared to before. Moreover, education is also the most crucial factor in human development (Trinh, 2023). Recognizing the importance of education in improving the quality of life also plays a significant role in a country's quality of life because education can enhance human resources. For example, the educational goals envisioned by Indonesia as stated in Republic of Indonesia Law No. 20 of 2003, which states, "National education aims to develop capabilities and shape the character and civilization of a dignified nation to enlighten the life of the nation, to develop the potential of students to become faithful and devoted individuals to the One and Only God, noble in character, healthy, knowledgeable, competent, creative, independent, and responsible citizens." The government can achieve these national educational goals by implementing the learning process.

Mathematics is widely recognized as a fundamental discipline that underpins technological advancement and scientific development. Beyond its cognitive dimension, mathematics education is intended to foster logical reasoning, precision, perseverance, and problem-solving skills that are essential for navigating real-life situations (Liu Sun, 2017; Abdurrahman et al., 2024). Despite its central role and continuous presence across all levels

of formal education in Indonesia, mathematics is often perceived by students as a difficult, abstract, and anxiety-inducing subject. This gap between the strategic importance of mathematics and students' learning experiences indicates a persistent educational challenge, suggesting that the way mathematics is taught may not yet fully support meaningful understanding, engagement, and positive attitudes toward the subject.

In response to these challenges, mathematical problem-solving emerges as a core competency that reflects the true essence of mathematics learning. Mathematics is intrinsically linked to problem-solving, as it offers a structured framework for analyzing situations, identifying patterns, and generating solutions to complex problems (Santos-Trigo, 2024). The development of mathematical problem-solving skills is therefore essential, as it nurtures students' critical thinking, logical reasoning, and analytical abilities—skills that are transferable across academic disciplines and real-life contexts (Novikasari, 2022). In an era marked by rapid technological advancement and data-driven decision-making, proficiency in mathematical problem-solving has become a key competency, enabling students to think systematically and creatively when confronted with increasingly complex challenges (St Omer et al., 2025).

Recent research underscores that mathematical problem-solving must be intentionally developed through effective instructional design. Problem-solving is recognized as a central learning outcome for applying mathematics in real-world contexts (Nilimaa, 2023), yet large-scale evidence from PISA 2022 indicates that students' mathematical competence—including problem-solving skills—is strongly shaped by socio-economic background, mathematics anxiety, self-efficacy, and school-level conditions (Ortega, 2025). Moreover, during the transition to lower secondary school, students' motivational profiles in mathematics tend to shift toward greater disengagement, which may hinder the development of problem-solving skills and highlights the need for deliberate school-level instructional strategies (Raufelder, 2023). Consistent with these findings, interviews with mathematics teachers at an Islamic junior high school in Central Java revealed that many students struggle to solve contextual problems, particularly in translating real-life situations into mathematical models and understanding underlying concepts. This persistent gap between instructional goals and classroom realities indicates an urgent need for learning approaches that explicitly strengthen students' mathematical problem-solving skills to support meaningful and sustainable learning outcomes.

Teachers also observed that conventional teaching materials—such as worksheets, textbooks, and teacher-prepared summaries—remain predominant in mathematics classrooms. While these resources provide basic practice, they often fall short in promoting meaningful problem-solving or connecting mathematical concepts to real-life contexts. To address this gap, approaches such as ethnomathematics and realistic mathematics education have been proposed, integrating cultural elements and real-life contexts into instruction to make learning more relevant and engaging. Research by Hidayat & Novikasari (2023) indicates that the use of a realistic approach can be particularly effective in enhancing students' skills, supporting the broader goal of intentionally cultivating these competencies through purposeful instructional design.

Building on the need to make mathematics learning more relevant and engaging, one example of cultural integration involves the traditional Banyumas musical instrument, *Kenthongan*, which exhibits geometric features in its design and structure. By relating mathematical concepts to familiar cultural artifacts such as the *Kenthongan*, students are expected to better understand abstract ideas and strengthen their problem-solving skills.

(Sharma & Orey, 2017; Novikasari et al., 2024). Preliminary observations suggest that connecting mathematics to students' cultural environment can enhance engagement and provide a meaningful context for learning.

Based on this context, the present study addresses the problem of students' limited problem-solving skills in mathematics. The research aims to investigate whether implementing an ethnomathematics-based learning module can significantly improve students' problem-solving skills, offering a novel approach that combines cultural relevance with systematic instructional design, specifically within Islamic junior high schools.

METHOD

This study employed a quasi-experimental design to investigate the effectiveness of ethnomathematics-based learning in enhancing the mathematical problem-solving abilities of ninth-grade students at an Islamic junior high school. The research hypothesis proposed that students who received instruction through ethnomathematics-based learning would demonstrate significantly higher problem-solving skills than those taught using expository instructional methods (Creswell, 2014).

Two intact science classes were selected through purposive sampling based on students' prior exposure to geometry topics and enrolment in parallel science tracks, ensuring comparable academic backgrounds. One class, comprising 24 students, was assigned as the experimental group, while the other class, with 23 students, served as the control group. The experimental group received mathematics instruction integrating ethnomathematical concepts derived from local culture, whereas the control group was taught using expository methods (Frankenstein, 1990).

Prior to the instructional intervention, both groups completed a pre-test designed to assess baseline problem-solving abilities in geometry, specifically focusing on curved-space shapes such as cylinders, cones, and spheres. The pre-test consisted of four items, each reflecting multiple indicators of mathematical problem-solving, including comprehension, strategy formulation, execution, and evaluation (Schoenfeld, 1987). Following a four-week instructional intervention, both groups completed a parallel post-test assessing the same problem-solving indicators. All test items had been previously validated, with validity coefficients ranging from 0.688 to 0.793, and demonstrated high reliability, with a reliability index of 0.750, confirming that the instruments were appropriate for measuring students' problem-solving skills (Herren et al., 2020).

During the intervention, the experimental group engaged in daily lessons incorporating ethnomathematical contexts. Each session began with discussions of local cultural practices related to mathematical concepts, followed by guided problem-solving exercises and collaborative learning activities. In contrast, the control group received expository instruction, emphasizing formula memorization and standard problem-solving exercises without cultural contextualization. The effectiveness of the intervention was evaluated using normalized gain (N-Gain) scores, classified according to Hake's (1998) criteria: >0.76 as highly effective, $0.55-0.75$ as moderately effective, $0.40-0.55$ as less effective, and <0.40 as not effective.

Data Analysis

Collected data were analysed using parametric statistical methods, specifically the independent samples t-test, to determine differences in mathematical problem-solving

abilities between the experimental and control groups. Prior to hypothesis testing, assumptions of normality and homogeneity of variance for the N-Gain scores were examined. The independent-samples t-test was subsequently applied using Jamovi software to evaluate the effectiveness of ethnomathematics-based intervention. The significance level was set at $\alpha = 0.05$, and effect sizes were calculated to determine the practical significance of the observed differences (Cohen, 1988).

RESULT AND DISCUSSION

Experimental Design

This study investigated the effectiveness of an ethnomathematics-based learning module in improving ninth-grade students' mathematical problem-solving skills at an Islamic Junior High School. Figure 1 presents a comparison of students' performance in the experimental and control groups, including the maximum, minimum, and mean N-gain scores.

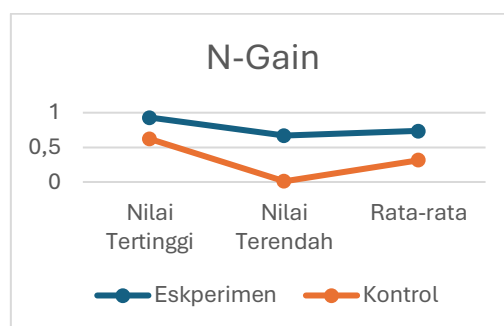


Figure 1. Comparison of Students' Scores in Experimental and Control Classes

The descriptive analysis of the N-gain scores demonstrates a substantial difference in learning improvement between the two groups. The experimental group attained a considerably higher maximum N-gain score (0.93) than the control group (0.62), indicating that the ethnomathematics-based module enabled several students to achieve near-optimal learning gains. This finding suggests that contextualized mathematical instruction grounded in students' cultural experiences can significantly enhance conceptual understanding and problem-solving performance.

Moreover, the minimum N-gain score in the experimental group (0.67) remained relatively high, reflecting a consistent level of improvement across students. This result implies that the instructional intervention was effective not only for high-achieving students but also for those with initially lower mathematical performance. Such consistency aligns with previous studies reporting that ethnomathematics-based learning reduces learning gaps by making mathematical concepts more meaningful and accessible to diverse learners (D'Ambrósio, 2001).

In contrast, the control group exhibited a much wider variability in learning gains. The extremely low minimum N-gain score (0.01) indicates that some students experienced almost no improvement during the learning process. Furthermore, the mean N-gain score of the control group (0.317) was substantially lower than that of the experimental group (0.737). According to Hake's (1998) classification, the experimental group's mean N-gain falls within the high improvement category, whereas the control group's mean corresponds to a low to moderate improvement level.

These findings indicate that the expository instructional approach implemented in the control group was less effective in enhancing students' mathematical problem-solving

skills. Recent studies consistently show that improvements in problem-solving are more pronounced when instruction actively engages students in meaningful, contextualized tasks that promote reasoning, representation, and sense-making (Fülöp, 2021). In contrast, the absence of cultural and real-life contexts in expository instruction may reduce students' cognitive engagement and limit their ability to connect abstract mathematical concepts with authentic situations, which is increasingly recognized as a critical factor in effective mathematics learning and problem-solving development (Santos-Trigo, 2024). Overall, the descriptive results indicate that the ethnomathematics-based learning module not only produced higher average learning gains but also resulted in more consistent improvements across students. This pattern strengthens the argument that integrating local cultural contexts into mathematics enhances both learning effectiveness and equity, particularly in problem-solving-oriented learning environments (Ding et al., 2023). These findings are further supported by recent international evidence; a comprehensive literature review by Batiibwe (2025) concluded that ethnomathematics is widely valued in mathematics education for its ability to connect mathematical ideas with learners' cultural environments, foster context-relevant problem-solving, and increase motivation among diverse student populations. Together, these results underscore the pedagogical potential of ethnomathematics to promote meaningful and inclusive development of mathematical problem-solving skills.

Effectiveness of Ethnomathematics-Based Learning: T-Test Results

An independent samples t-test was employed to examine differences in the mean N-gain scores of students' mathematical problem-solving skills between the experimental and control groups. Prior to conducting the inferential analysis, the assumptions of normality and homogeneity of variance were examined and confirmed, indicating that the datasets satisfied the required conditions for parametric testing (Ghasemi & Zahediasl, 2012). Table 1 summarizes the results of the independent samples test.

The results of the independent-samples t-test revealed a statistically significant difference in N-gain scores between the two groups, $t(45) = 10.30, p < .001$. Students in the experimental group, who participated in ethnomathematics-based learning, demonstrated significantly higher improvements in mathematical problem-solving skills compared to those in the control group. This finding indicates that the instructional intervention was effective in enhancing students' learning outcomes.

Table 1. Independent-Samples T-Test of N-Gain Scores

Independent Samples T-Test						
		Statistic	df	p	Effect Size	
N-Gain	Student's t	10.3 ^a	45.0	< .001	Cohen's d	3.01

Note. $H_a: \mu_1 \neq \mu_2$

^a Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances

In addition to statistical significance, the magnitude of the observed difference was substantial. The calculated effect size (Cohen's $d = 3.01$) represents a very large effect, suggesting that the ethnomathematics-based learning module had a strong and

meaningful impact on students' problem-solving performance (Cohen, 1988). Such a large effect size implies that the improvement observed in the experimental group was not only statistically reliable but also educationally significant, exceeding what is typically achieved through conventional mathematics instruction.

The results of this study align with a growing body of research demonstrating that ethnomathematics-based instruction effectively enhances students' mathematical problem-solving and reasoning skills. Earlier studies have shown that embedding mathematics in culturally meaningful contexts supports students in linking abstract concepts to concrete experiences, thereby strengthening analytical reasoning (Suh & Calabrese, 2025). More recent empirical evidence from Indonesia further corroborates this view. Pratama and Yelken (2024) found that ethnomathematics-based learning has a strong effect on students' mathematical literacy across various studies, highlighting its effectiveness in enhancing understanding of mathematical concepts.

Building on these findings, the present study extends the evidence to Islamic junior high school settings, demonstrating that ethnomathematics-based modules can also significantly improve students' problem-solving skills in geometry, particularly when instruction is grounded in students' cultural and religious contexts.

From a theoretical perspective, the significant improvement in N-gain scores supports constructivist views of learning, which emphasize that knowledge is actively constructed through meaningful interaction with contextualized learning environments (Zajda, 2021). By situating mathematical problems within familiar cultural contexts, ethnomathematics-based learning encourages students to engage in deeper cognitive processing, facilitating the development of higher-order problem-solving skills. This aligns with recommendations from the National Council of Teachers of Mathematics (NCTM, 2000), which stress the importance of connecting mathematics instruction to students' real-world experiences to enhance understanding and reasoning.

Practically, these results indicate that integrating ethnomathematics into mathematics instruction can substantially enhance students' problem-solving abilities, foster higher-order thinking, and support the development of culturally responsive and inclusive learning environments. Recent international research confirms that ethnomathematics-based approaches are effective in promoting meaningful mathematical engagement by linking abstract concepts to learners' cultural experiences, which in turn strengthens reasoning and problem-solving processes (Batiibwe, 2025). Given the exceptionally large effect size observed in this study, ethnomathematics-based learning modules demonstrate strong potential as an instructional strategy for improving mathematics education, particularly in contexts where cultural relevance plays a crucial role in student engagement and equity.

Implementation of Learning in Experimental and Control Classes

Instruction in the control group was delivered through an expository teaching approach, in which the teacher functioned as the primary source of information while students assumed a predominantly receptive role. In this approach, the learning sequence typically begins with direct explanations of mathematical content, followed by examples and teacher-led questioning, with limited opportunities for active student exploration (Rittle-Johnson, 2024). The task illustrated in Figure 2 exemplifies this pattern, requiring students to identify familiar three-dimensional shapes and associate them with everyday objects. Although such tasks may support basic recognition and recall of geometric forms,

research indicates that teacher-centered expository methods alone offer restricted opportunities for students to engage in deep conceptual reasoning or complex problem solving compared to more interactive or constructivist approaches (Woods & Copur-Gencturk, 2024). These limitations can constrain students' engagement and inhibit the development of flexible problem-solving strategies that require exploration, sense-making, and connection to broader mathematical ideas.

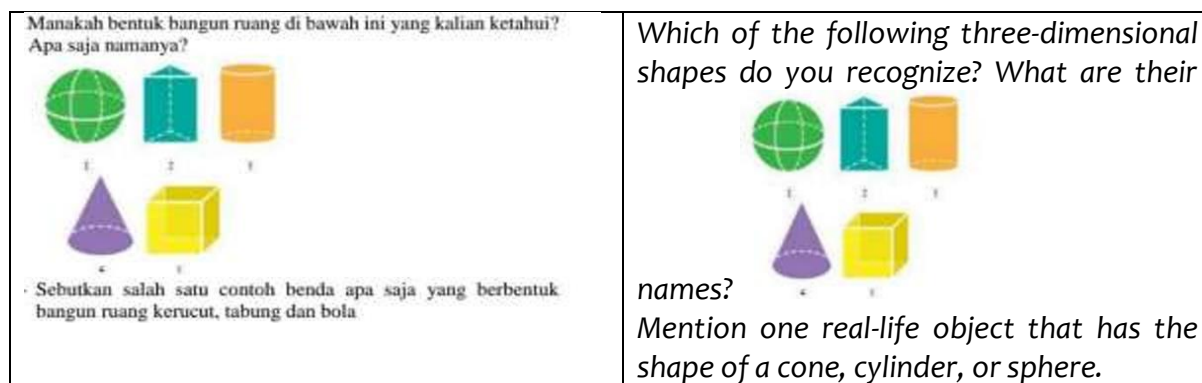


Figure 2. Example of a Content Used in the Control Group

From a pedagogical standpoint, expository instruction can be efficient for presenting well-structured content at the initial stage of learning, but its teacher-centered nature often limits students' active cognitive engagement, which is critical for developing deep mathematical understanding and flexible problem-solving strategies (Cents-Boonsta et al., 2021). Research in mathematics education highlights that instructional approaches emphasizing explanation and recall, rather than exploration and learner construction, tend to result in uneven learning outcomes and superficial conceptual grasp, particularly in geometry where spatial reasoning and visualization are essential for sense-making and higher-order thinking (Weigand et al., 2025). These pedagogical limitations help explain the comparatively modest and varied learning gains observed in the control group, as students had fewer opportunities to engage in reasoning, representation, and generative activities necessary for robust problem solving.

In contrast, learning in the experimental group was implemented using an ethnomathematics-based geometry module that explicitly connected formal mathematical concepts with students' cultural knowledge and everyday experiences. For example, one core learning activity involved using a *Kenthongan*, a traditional bamboo musical instrument, as a contextual representation of a cylindrical solid. Students were guided to observe a visual representation of the *Kenthongan* with its conceptually unfolded surface to resemble the net of a cylinder, allowing them to explore geometric properties such as the curved lateral surface and circular bases through a culturally meaningful lens. Research on ethnomathematics emphasizes that integrating familiar cultural artifacts into mathematics instruction makes abstract concepts more accessible and relevant to students, facilitating deeper engagement and understanding (Batiibwe, 2025). Such contextualization supports students in bridging everyday experience with formal geometric reasoning, enhancing their ability to visualize and reason about spatial structures within meaningful cultural contexts.

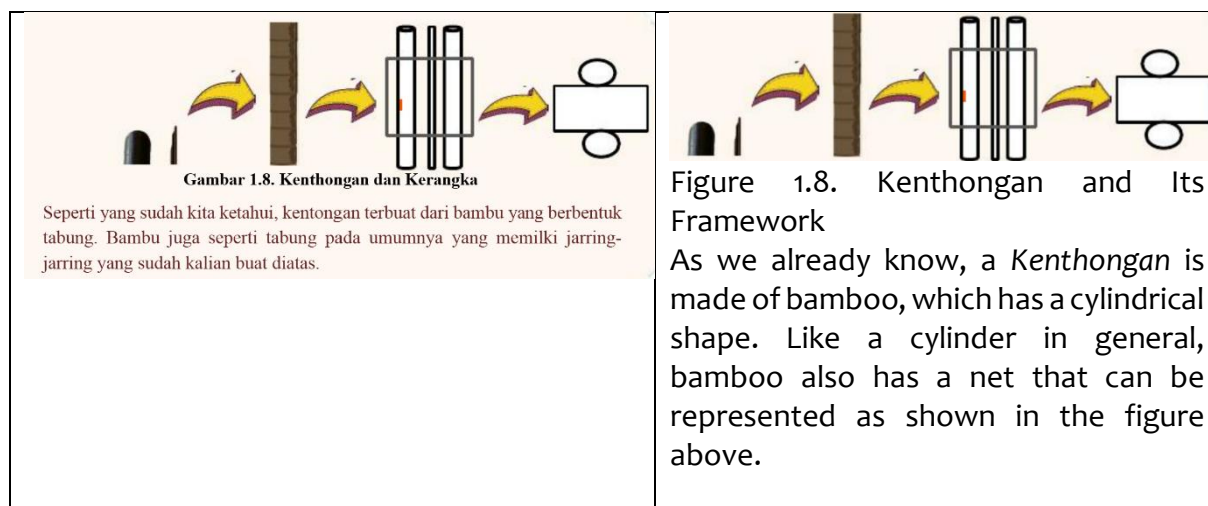


Figure 3. Example of a Content Used in the Experiment Group

This instructional design enabled students to visualize abstract geometric ideas through culturally familiar artifacts, thereby supporting meaning-making and conceptual understanding. Contemporary research on culturally responsive mathematics pedagogy demonstrates that anchoring mathematical concepts in students' cultural backgrounds helps learners make meaningful connections between informal knowledge and formal mathematical structures, enhancing conceptual clarity and reducing abstraction barriers (Abdulrahim & Orosco, 2020). Empirical evidence further shows that ethnomathematics approaches facilitate learners' understanding of geometric concepts by making abstract ideas accessible through familiar cultural referents, improving engagement and retention (Batiibwe, 2025). These findings underscore that culturally grounded representations not only contextualize geometry learning but also support students' ability to reason about spatial structures within authentic cultural contexts.

Rather than merely identifying shapes, students in the experimental group were encouraged to analyze geometric structures, interpret representations, and reason about relationships between real-world objects and mathematical models. Contemporary research on culturally responsive mathematics instruction highlights that learning designs rooted in students' cultural experiences support deeper engagement and foster flexible mathematical thinking by connecting formal content with familiar contexts (Abdulrahim & Orosco, 2020). This aligns with constructivist perspectives, which emphasize that understanding develops through active exploration and the integration of new ideas with learners' existing cognitive frameworks (Zajda, 2021). Consequently, ethnomathematics-based instruction provided a richer and more demanding learning environment that supported higher-order thinking and more robust mathematical problem-solving.

CONCLUSION

This study demonstrates that ethnomathematics-based learning significantly enhances ninth-grade students' mathematical problem-solving skills, particularly in geometry. Students in the experimental group achieved higher N-Gain scores and exhibited more consistent improvements in analyzing geometric structures, reasoning about relationships between objects and mathematical models, and applying strategies to solve complex problems compared to those in the expository instruction group. These

findings confirm that situating mathematical content within culturally meaningful contexts, such as using the *Kenthongan* to represent cylindrical solids, provides a rich environment for developing higher-order problem-solving abilities. Based on these results, it is recommended that educators implement ethnomathematics-based learning across other mathematical domains, provide professional development to help teachers design culturally responsive problem-solving activities, and integrate ethnomathematics into the curriculum to foster students' adaptive and critical problem-solving skills. Additionally, future research should explore the long-term impact of such culturally grounded approaches on problem-solving performance across different grade levels and diverse student populations.

REFERENCES

- Abdurrahman, A., Hidayah, F., Dhiauddin, D., & Fanani, Z. (2024). Artificial Intelligence as an Assistant and Generator of Student Learning in Islamic University. *Al-Ta'lim Journal*, 31(3). doi:<https://doi.org/10.15548/jt.v31i3.960>
- Abdulrahim, N.A., & Orosco, M.J. (2020). Culturally Responsive Mathematics Teaching: A Research Synthesis. *Urban Rev* 52, 1–25. <https://doi.org/10.1007/s11256-019-00509-2>
- Batiibwe, M.S.K. (2025). Ethnomathematics as a pedagogical tool for mathematics education: opportunities and challenges. *SN Soc Sci* 5, 221. <https://doi.org/10.1007/s43545-025-01260-0>
- Cents-Boonstra, M., Lichtwarck-Aschoff, A., Denessen, E., Aelterman, N., & Haerens, L. (2021). Fostering student engagement with motivating teaching: an observation study of teacher and student behaviours. *Research Papers in Education*, 36(6), 754–779. <https://doi.org/10.1080/02671522.2020.1767184>
- Cohen J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillside, NJ: Lawrence Erlbaum Associates.
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (4th ed.). Thousand Oaks, CA: Sage.
- D'Ambrósio U. (2001). *Etnomatemática: elo entre as tradições e a modernidade* (Ethnomathematics: link between tradition and modernity). Belo Horizonte: Autêntica.
- Ding, M., Huang, R., Li, X., Li, Y. (2023). Understanding and Improving Mathematics Instruction Through a Cultural Lens. In: Cai, J., Stylianides, G.J., Kenney, P.A. (eds) *Research Studies on Learning and Teaching of Mathematics. Research in Mathematics Education*. Springer, Cham. https://doi.org/10.1007/978-3-031-35459-5_5
- Fülöp, É. (2021). Developing Problem-Solving Abilities by Learning Problem-Solving Strategies: An Exploration of Teaching Intervention in Authentic Mathematics Classes. *Scandinavian Journal of Educational Research*, 65(7), 1309–1326. <https://doi.org/10.1080/00313831.2020.1869070>

- Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: a guide for non-statisticians. *International journal of endocrinology and metabolism*, 10(2), 486–489. <https://doi.org/10.5812/ijem.3505>
- Hake, R. R. (1998). Interactive engagement versus traditional methods: A six thousand student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66(1), 64-74
- Herren, R.V., Ary, D., Jacobs, L.C., Irvine, C.K., Walker, D.A., & Arrington, W. (2020). Introduction to Research in Education (10th ed.). *International Journal of Research*, 7, 1-2.
- Hidayat, L. D., & Novikasari, I. (2023). [Effectiveness of realistic mathematics approach to increasing mathematical representation ability at SMP N 9 Purwokerto](https://doi.org/10.24090/ijrme.v1i2.9139). *International Journal of Research in Mathematics Education*, 1(2), 116-125, <https://doi.org/10.24090/ijrme.v1i2.9139>
- Liu Sun, K. (2018). The Role of Mathematics Teaching in Fostering Student Growth Mindset. *Journal for Research in Mathematics Education*, 49(3), 330–355. <https://doi.org/10.5951/jresmetheduc.49.3.0330>
- Nilimaa, J. (2023). New Examination Approach for Real-World Creativity and Problem-Solving Skills in Mathematics. *Trends in Higher Education*, 2(3), 477-495. <https://doi.org/10.3390/higheredu2030028>
- Novikasari, I. (2022). Keterampilan Berpikir Matematika. Purwokerto: Saizu Publisher.
- NCTM (2000). Principles and standards for school mathematics. Reston, VA: NCTM.
- Ortega-Rodríguez, P. J. (2025). PISA 2022: Predictors of the mathematics achievement of Spanish students in Secondary Education. *Revista de Psicodidáctica*, 30 (1), <https://doi.org/10.1016/j.psicoe.2024.500152>.
- Pratama, R.A., & Yelken, T.Y. (2024). Effectiveness of ethnomathematics-based learning on students' mathematical literacy: a meta-analysis study. *Discov Educ* 3, 202, <https://doi.org/10.1007/s44217-024-00309-1>
- Raufelder, D., Hoferichter, F., Hirvonen, R., & Kiuru, N. (2022). How students' motivational profiles change during the transition from primary to lower secondary school. *Contemporary Educational Psychology* 71, 1-14, <https://doi.org/10.1016/j.cedpsych.2022.102117>
- Rittle-Johnson, B. (2024). Encouraging students to explain their ideas when learning mathematics: A psychological perspective. *The Journal of Mathematical Behavior*, 76, <https://doi.org/10.1016/j.jmathb.2024.101192>.
- Santos-Trigo, M. (2024). Problem solving in mathematics education: tracing its foundations and current research-practice trends. *ZDM Mathematics Education* 56, 211–222. <https://doi.org/10.1007/s11858-024-01578-8>

- Schoenfeld, A. H. (1987). Pólya, Problem Solving, and Education. *Mathematics Magazine*, 60(5), 283-291, <https://doi.org/10.2307/2690409>
- Sharma, T., & Orey, D.C. (2017). Meaningful Mathematics Through the Use of Cultural Artifacts. In: Rosa, M., Shirley, L., Gavarrete, M., Alangui, W. (eds) *Ethnomathematics and its Diverse Approaches for Mathematics Education*. ICME-13 Monographs. Springer, Cham. https://doi.org/10.1007/978-3-319-59220-6_7
- Suh, J.M., & Calabrese, S.C. (2025). Culturally responsive mathematics engagement through a family-inspired mathematizing routine. *Educ Stud Math*. <https://doi.org/10.1007/s10649-025-10411-2>
- St Omer, S.M., Evers, K., Wang, CY. et al. (2025). Technology-enhanced mathematics learning: review of the interactions between technological attributes and aspects of mathematics education from 2013 to 2022. *Humanit Soc Sci Commun* 12, 1079. <https://doi.org/10.1057/s41599-025-05475-7>
- Trinh, N.T.H. Higher Education and Its Role for National Development. A Research Agenda with Bibliometric Analysis. *Interchange* 54, 125–143 (2023). <https://doi.org/10.1007/s10780-023-09493-9>
- Weigand, HG., Hollebrands, K. & Maschietto, M. Geometry education at secondary level – a systematic literature review. *ZDM Mathematics Education* 57, 829–843 (2025). <https://doi.org/10.1007/s11858-025-01703-1>
- Woods, P., & Copur-Gencturk, Y. (2024). Examining the role of student-centered versus teacher-centered pedagogical approaches to self-directed learning through teaching. *Teaching and Teacher Education*, 138, <https://doi.org/10.1016/j.tate.2023.104415>
- Zajda, J. (2021). Constructivist Learning Theory and Creating Effective Learning Environments. In: *Globalisation and Education Reforms*. Globalisation, Comparative Education and Policy Research, vol 25. Springer, Cham. https://doi.org/10.1007/978-3-030-71575-5_3